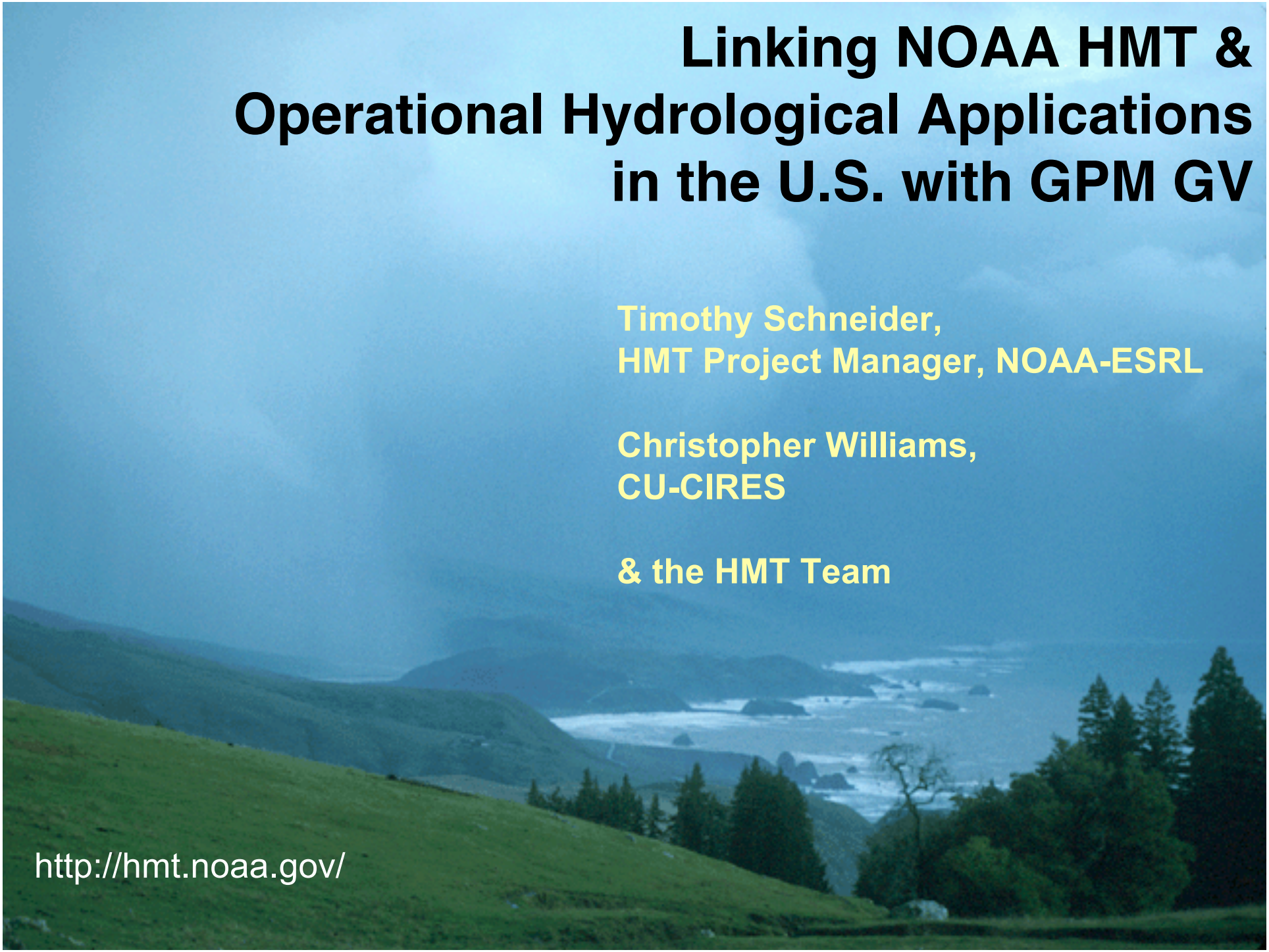


Linking NOAA HMT & Operational Hydrological Applications in the U.S. with GPM GV

Timothy Schneider,
HMT Project Manager, NOAA-ESRL

Christopher Williams,
CU-CIRES

& the HMT Team

http://hmt.noaa.gov/

Roadmap to Today's Presentation

1. Overview of NOAA HMT
   - Focus is on Research to Operations (R2O)
   - A Testbed Describes a Process
2. HMT within the Framework of GPM GV
   - National Network
   - Physical Validation
   - Integrated Hydrological Validation
3. Proposed Partnership/Collaboration between HMT & GPM GV Template
   - Science Objectives
   - Management / Infrastructure
   - Work Projects

NOAA National Weather Service (NWS) Hydrology Science and Technology Infusion Program (STIP)

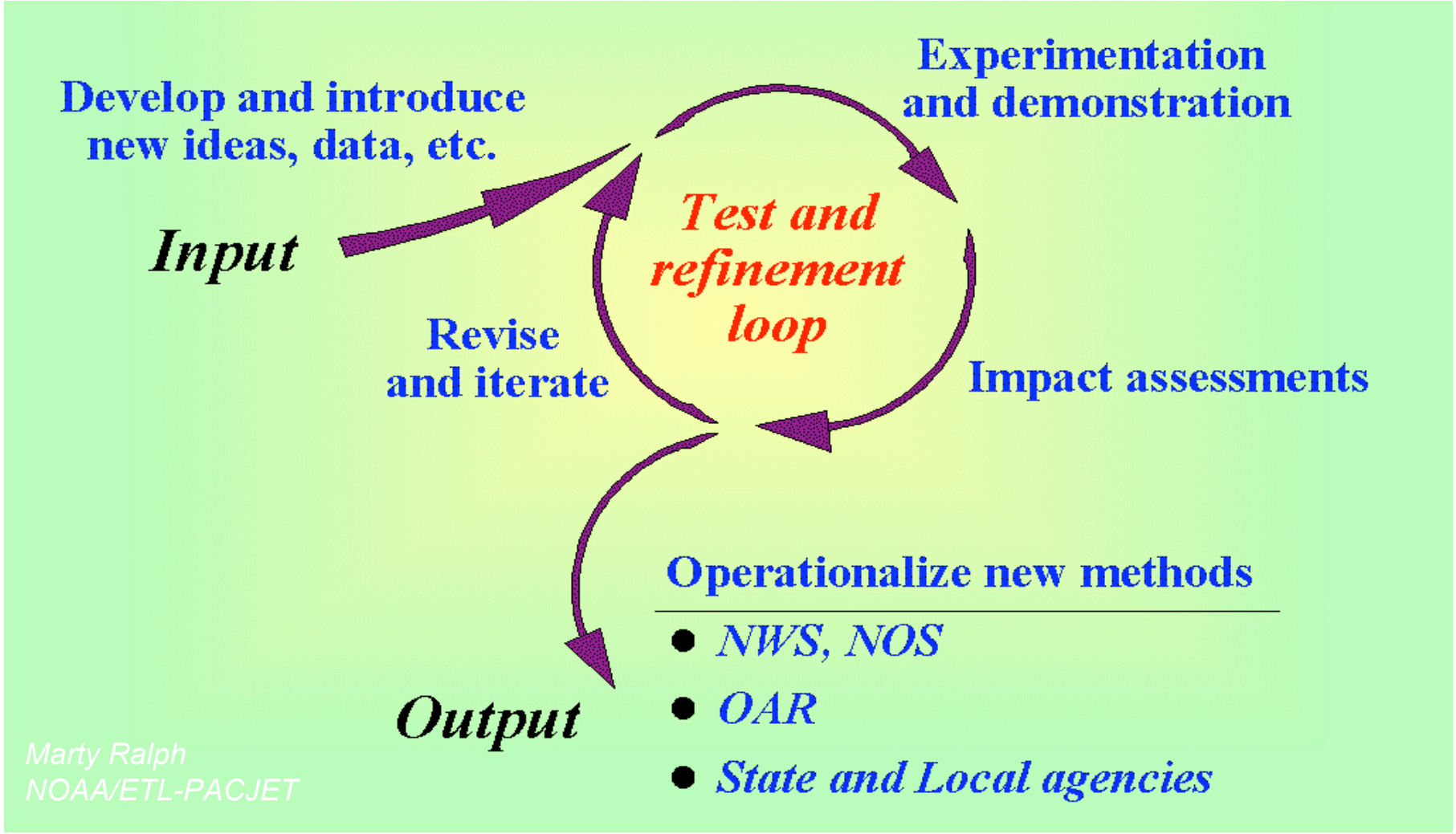
★ Recommended by USWRP ★

- As NOAA considers the future of its integrated regional, surface, and tropospheric observing systems (information online at www.nws.noaa.gov/ost/STIP2004.pdf), it faces a key question addressed by this workshop—how to optimize the development and deployment of new measurement systems so as to strengthen the mesoscale observation and prediction capabilities over the United States. *Testbeds can point the way toward filling this need, and, thus, they became a major focus of the workshop*.
- Test beds defined. The TBWG developed the following consensus definition of a test bed (Fig. 1):
  - *A testbed is a working relationship in a quasi-operational framework among measurement specialists, forecasters, researchers, the private sector, and government agencies aimed at solving operational and practical regional problems with a strong connection to the end users.* Outcomes from a testbed are more effective observing systems, better use of data in forecasts, improved services, products, and economic/public safety benefits. Testbeds accelerate the translation of R&D findings into better operations, services, and decision-making. A successful testbed requires physical assets as well as substantial commitments and partnerships.

From: Dabberdt et. al. 2005 "MULTIFUNCTIONAL MESOSCALE OBSERVING NETWORKS" Bull. Amer. Meteor. Soc. pp. 961--982

The HMT Concept

Testbed as a Process



See: Dabberdt et. al. 2005 Bull. Amer. Meteor. Soc.

Roadmap to Today's Presentation

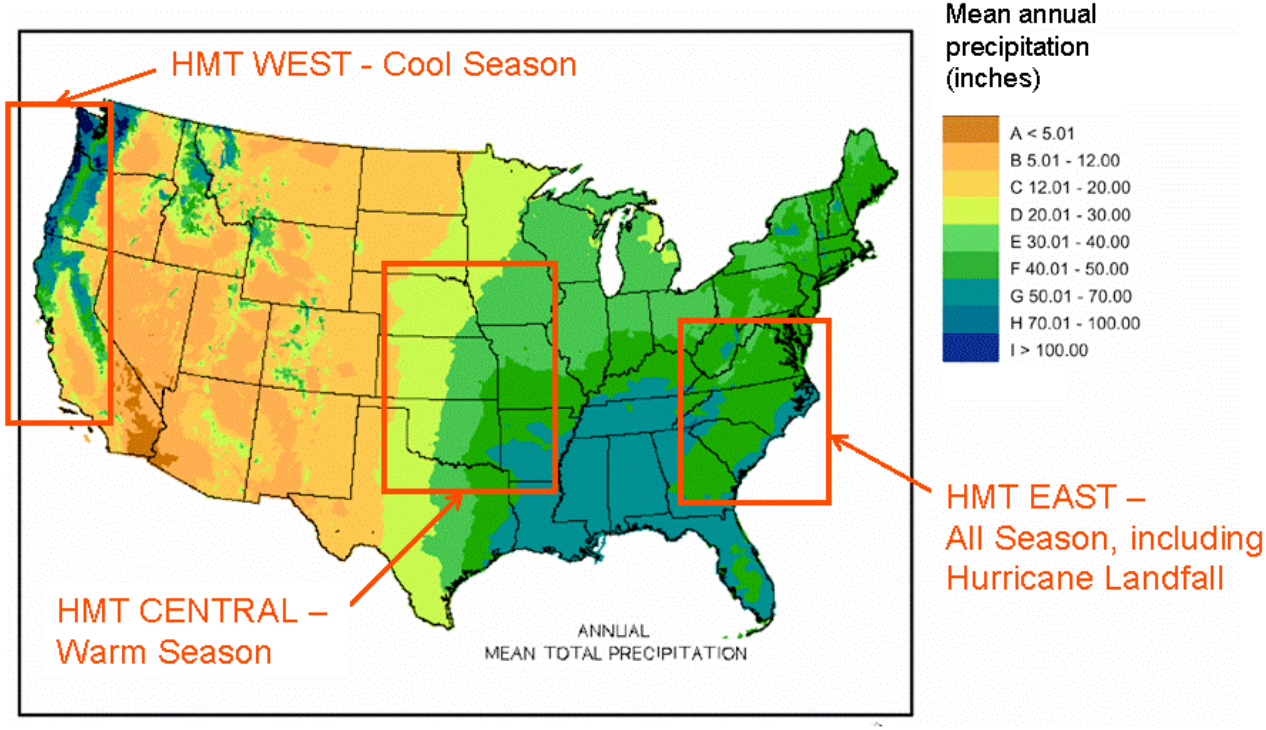
2. HMT within the Framework of GPM GV
   - **National Network**
     - **Regional Implementation Strategy**
     - **HMT Timeline – Past and into the GPM era**
   - Physical Validation
     - HMT-West Implementation
     - HMT-West Data Management
   - Integrated Hydrological Validation
     - Decision Support Tools
     - Models to Address:
       - Downscaling
       - QPF and QPE

NOAA's Hydrometeorological Testbed (HMT) Program

A National Testbed Strategy with Regional Implementation

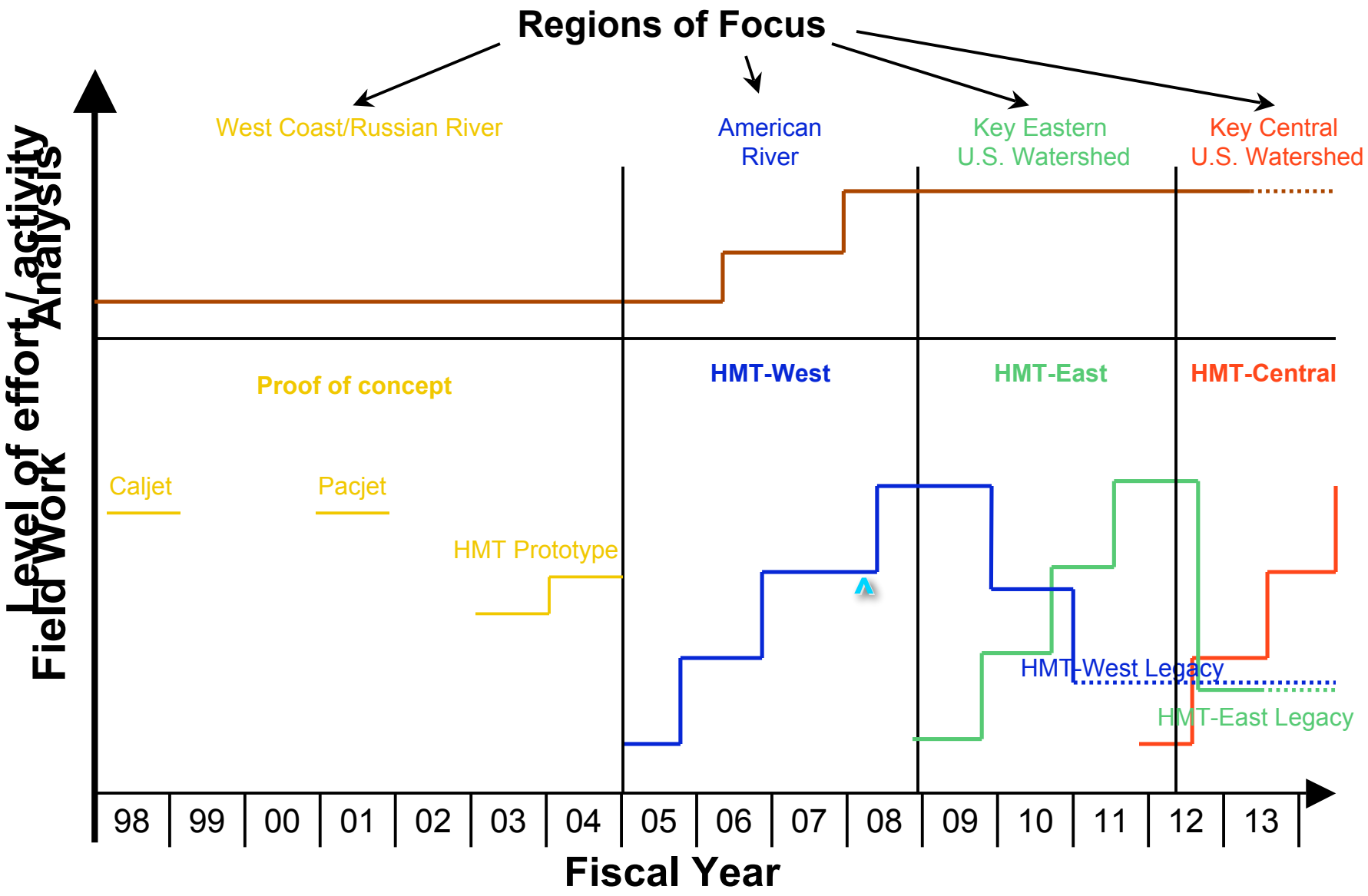
Major Activity Areas

- Quantitative Precipitation Estimation (QPE)
- Quantitative Precipitation Forecasts (QPF)
- Snow level and snow pack
- Hydrologic Applications & Surface Processes
- Decision Support Tools
- Verification
- Enhancing & Accelerating Research to Operations
- Building partnerships



Benefits: Accelerates improvements in QPE/F and flood forecasting, with impacts on emergency management, flood control and water resource management, ecosystems, and transportation. Science and field tests will advise on how best to fill gaps in observational and modeling systems.

Hydrometeorology Testbed Timeline



NOAA Hydrology Program
(Water Resources Data Assimilation)

NOAA Science and Technology Infusion Program
(Hydrometeorology Testbed)

Roadmap to Today's Presentation

2. HMT within the Framework of GPM GV
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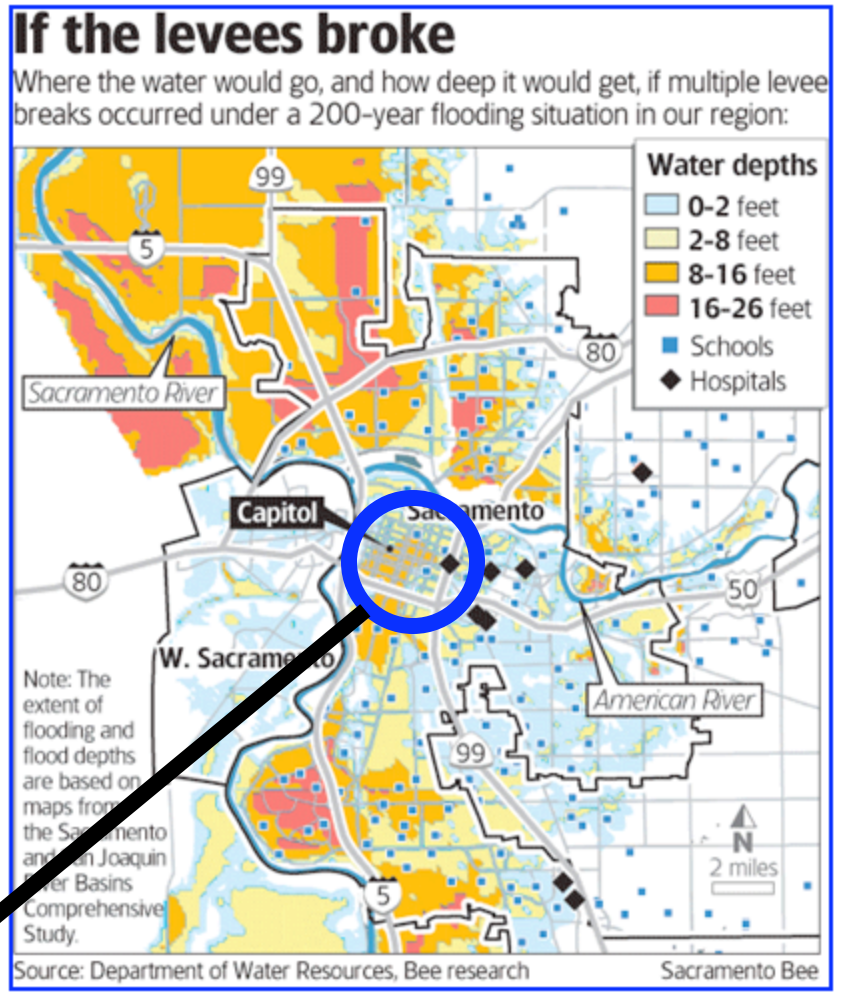
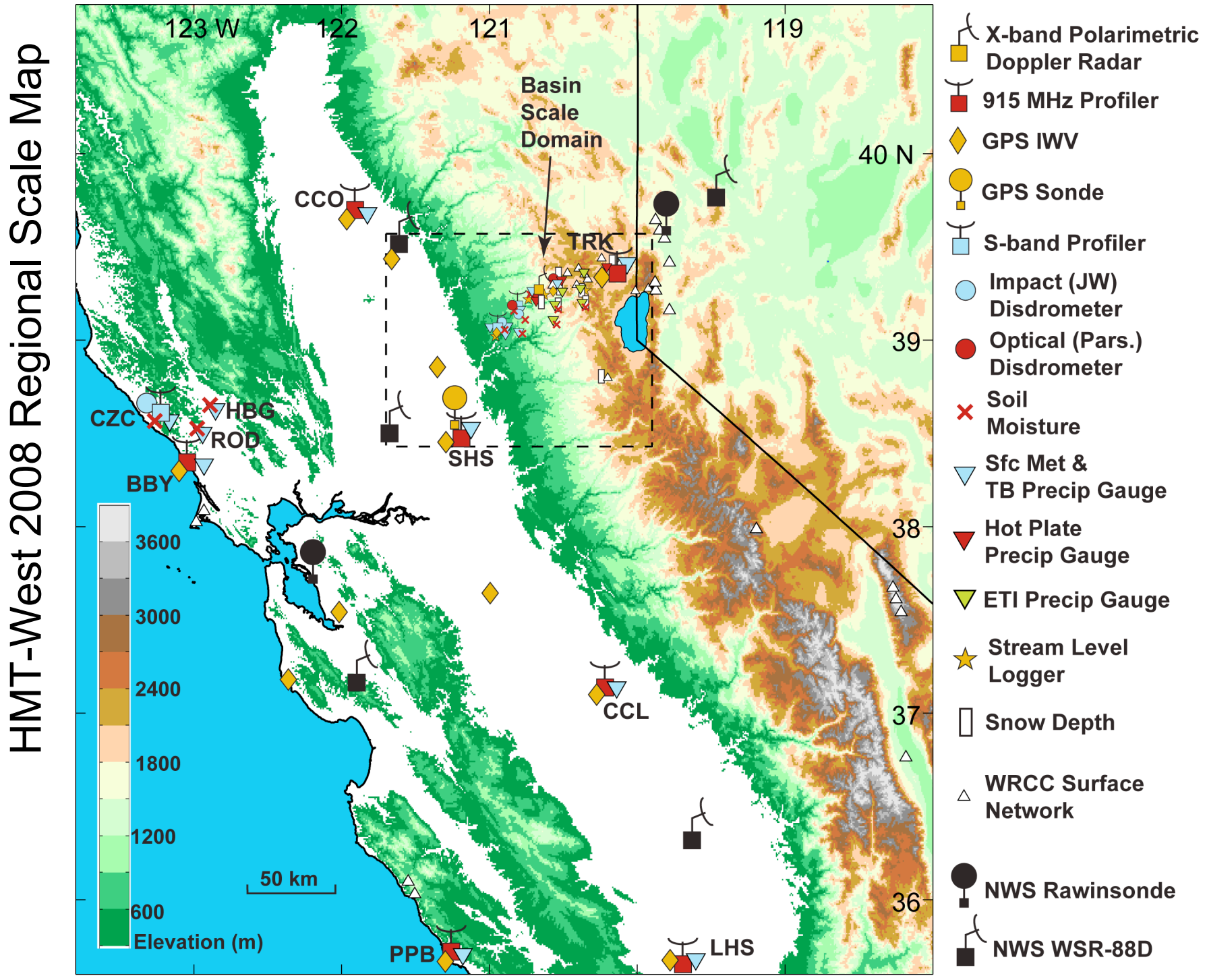
The Sacramento Flood Risk

- Complex water resource management issues in an urban area with large societal impacts
  - –Large demand for water/hydropower
  - –Threat of devastating flood

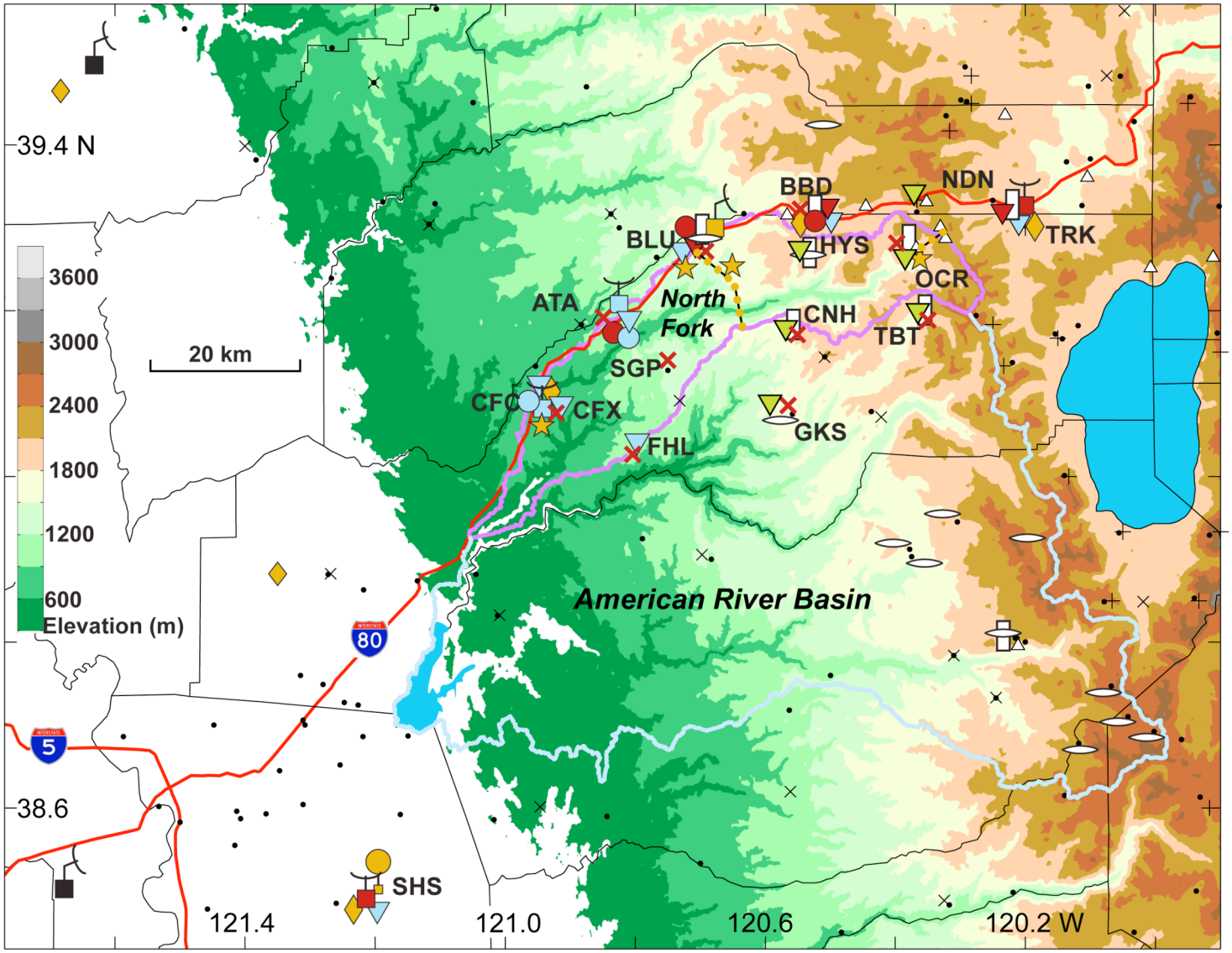
Photo by Bryan Patrick, Sacramento Bee



several feet inundation possible in downtown Sacramento


HMT-West 2008 Regional Scale Map
123 W
122
121
119
40 N
39
38
37
36
Basin
Scale
Domain
CCO
TRK
SHS
CZC
HBG
ROD
BBY
CCL
LHS
PPB
3600
3000
2400
1800
1200
600
Elevation (m)
50 km
X-band Polarimetric
Doppler Radar
915 MHz Profiler
GPS IWV
GPS Sonde
S-band Profiler
Impact (JW)
Disdrometer
Optical (Pars.)
Disdrometer
Soil
Moisture
Sfc Met &
TB Precip Gauge
Hot Plate
Precip Gauge
ETI Precip Gauge
Stream Level
Logger
Snow Depth
WRCC Surface
Network
NWS Rawinsonde
NWS WSR-88D

HMT-West 2008 Basin Scale Map



HMT Observing Systems

- X-band Polarimetric Doppler Radar
- 915 MHz Profiler
- GPS IWV
- GPS Sonde
- S-band Profiler
- Impact (JW) Disdrometer
- Optical (Pars.) Disdrometer
- Soil Moisture
- Sfc Met & TB Precip Gauge
- Hot Plate Precip Gauge
- ETI Precip Gauge
- Stream Level Logger
- Hi-Resolution Temperature Transects
- Snow Depth

Operational and Long Term Observing Systems

NWS WSR-88D · ALERT Precip. Gauge · ALERT Snow Pillow · × RAWS Precip. Gauge · + SNOTEL Precip. Gauge and Snow Pillow · △ WRCC Surface Network

HMT-West Data Management

Low QC Data Stream (Rain gauges, disdrometers, surface met, etc.)

Real Time
Decision Support Tools
→ **Graphical Images , ASCII Data**
Web based, hourly update

Post-IOP
Low-level QC; hrly to wkly
→ **Graphical Images, ASCII Data**
Archived on web/ftp site

High QC Data Stream (Scanning radars, Profilers, Experimental Instruments, etc.)

Real Time
Decision Support Tools
→ **Graphical Images**
Web based, 10/60 min update

Post-IOP
Data is QC'd
→ **QPE Products** (Rain Rate, FL)
Images and Data on ftp site

Post Campaign – Instrument PI stores raw data, provides raw data to HMT and non-HMT collaborators at PI's discretion (*need protocol*)

Roadmap to Today's Presentation

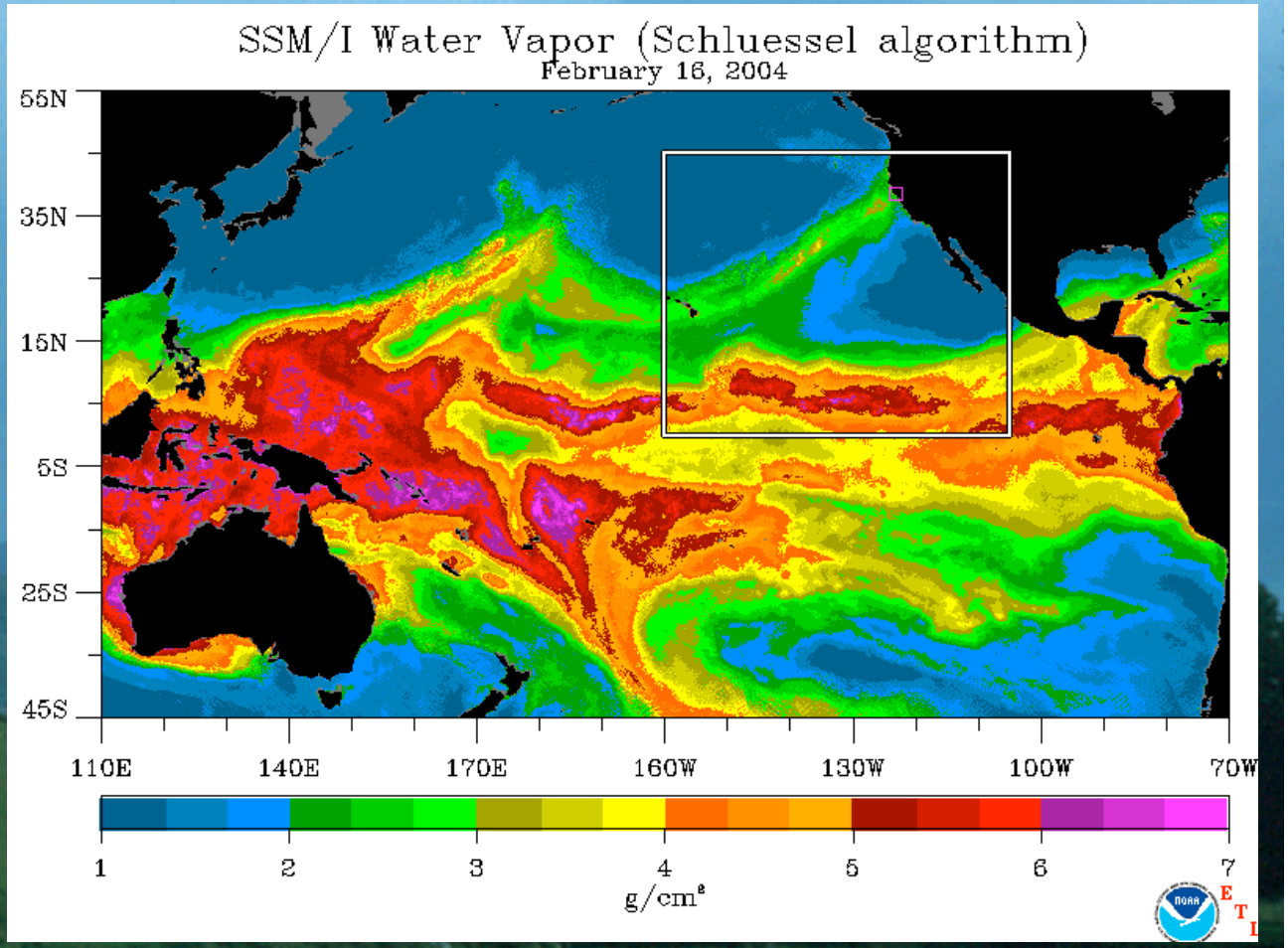
2. HMT within the Framework of GPM GV
   - National Network
     - Regional Implementation Strategy
     - HMT Timeline – Past and into the GPM era
   - Physical Validation
     - HMT-West Implementation
     - HMT-West Data Management
   - **Integrated Hydrological Validation**
     - **Decision Support Tools**
     - **Models to Address:**
       - **Downscaling**
       - **QPF and QPE**

Developing Decision Support Tools (EPIS)

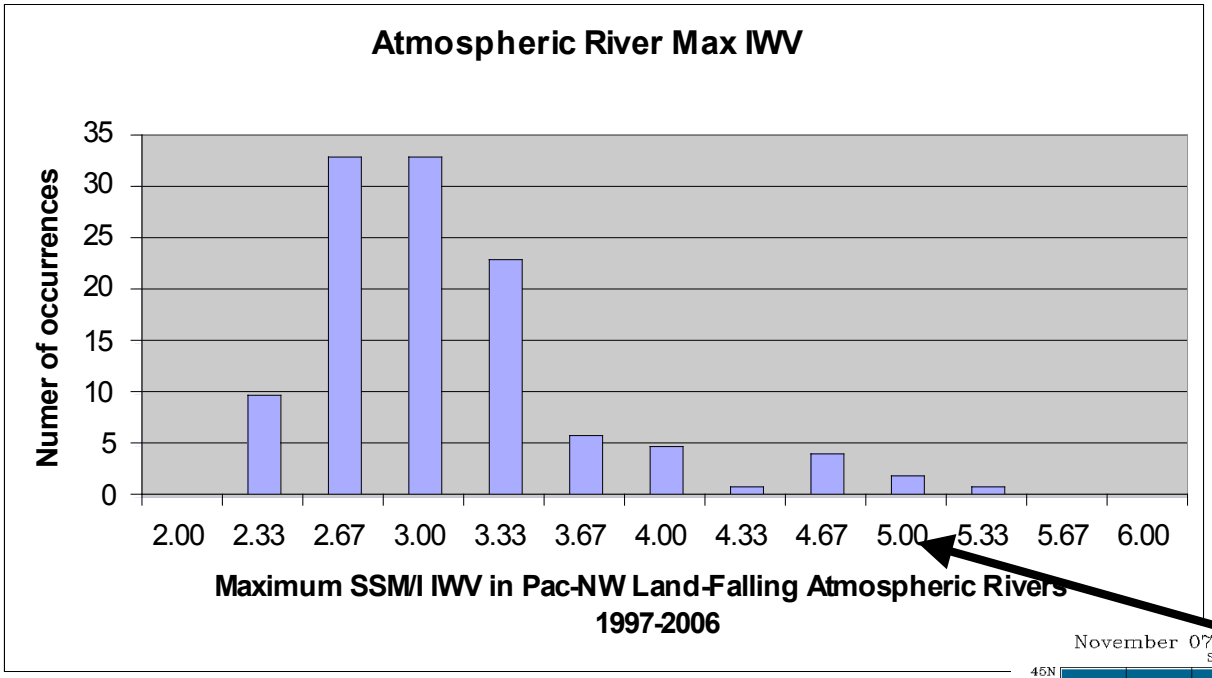
- A Decision Support Tool helps forecasters interpret multi-sensor observations, etc.

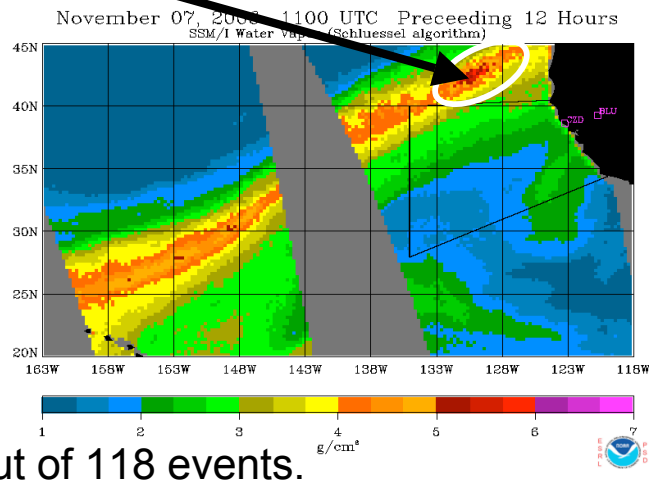
Example:

- Atmospheric River Decision Support Tool



A Histogram of AR Strength



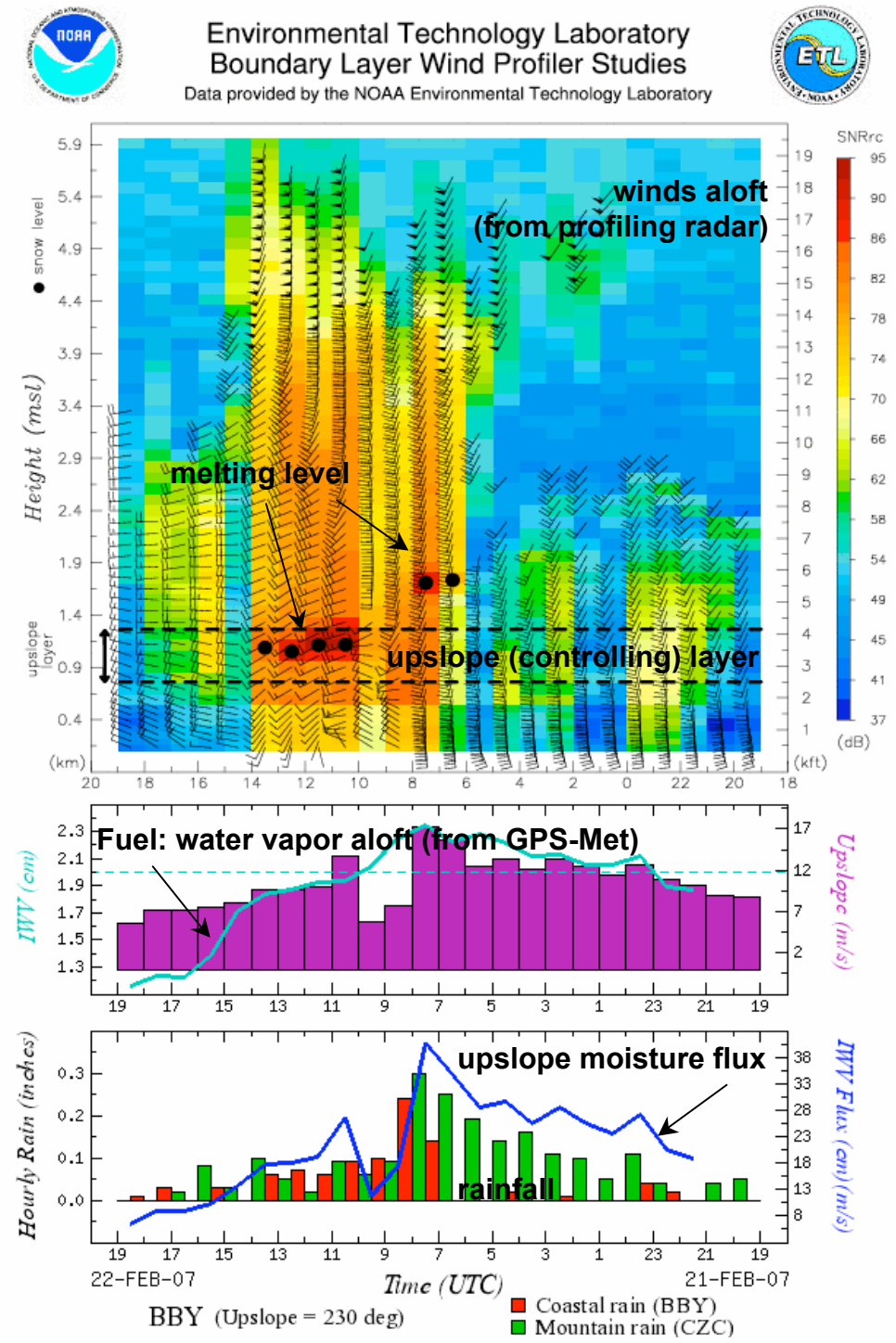


Conclusion:

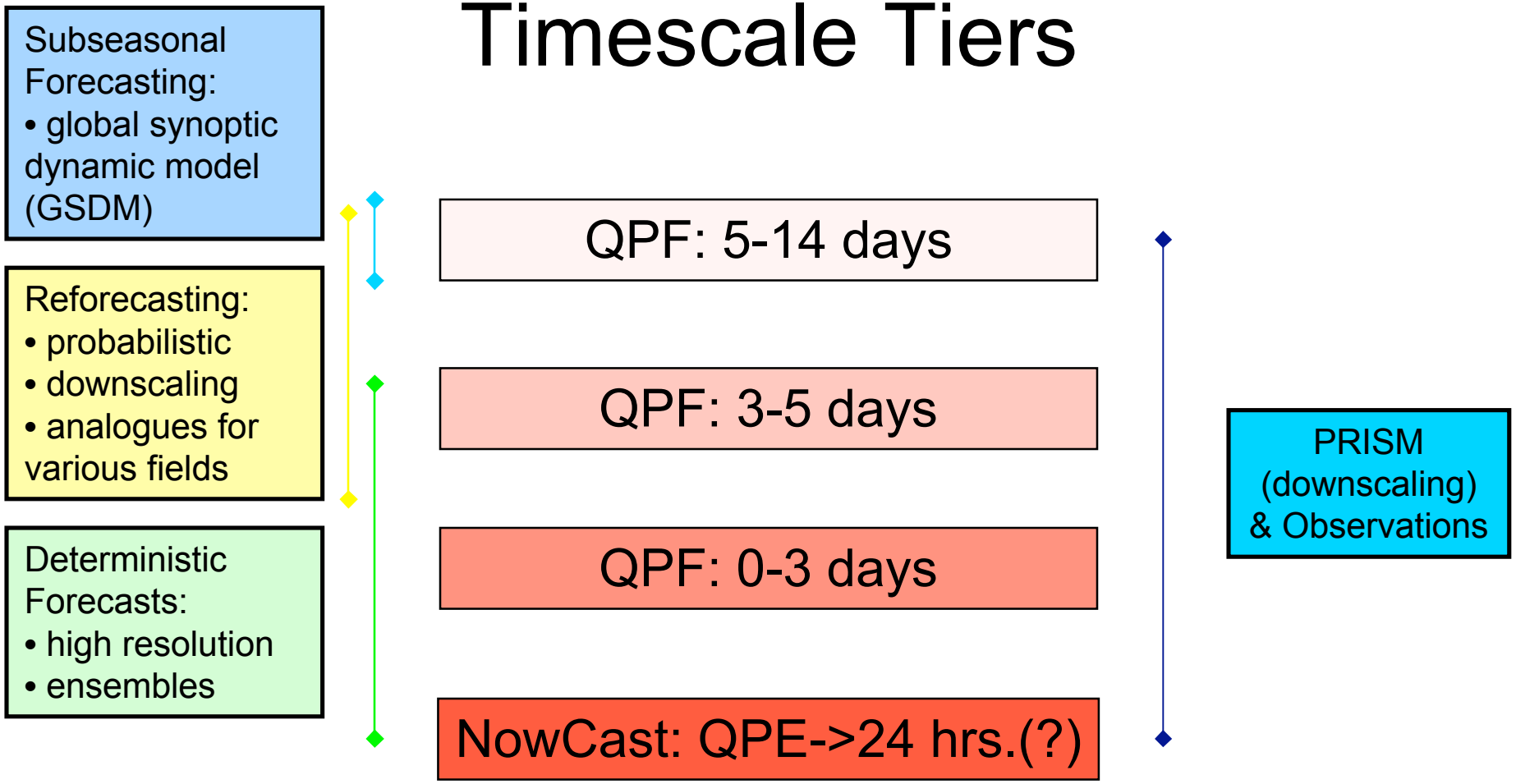
The Fall 2006 event in the Pac-NW was associated with a landfalling atmospheric river. This is similar to the Ralph et al. (2006, GRL) result for the Russian River floods from 1997-2006.

The event was tied for 2nd in terms of maximum IWV out of 118 events.

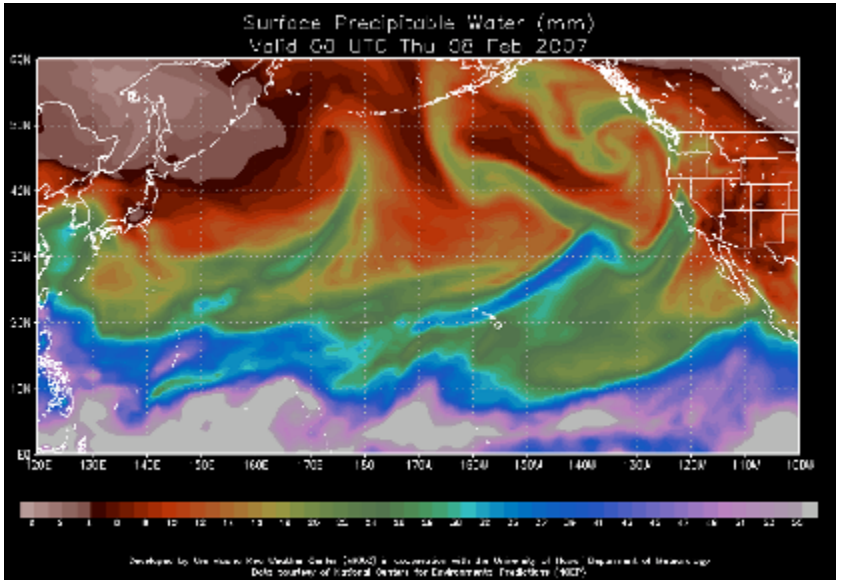
Snow Level & Moisture Flux Products



Quantitative Precipitation Forecasting Timescale Tiers

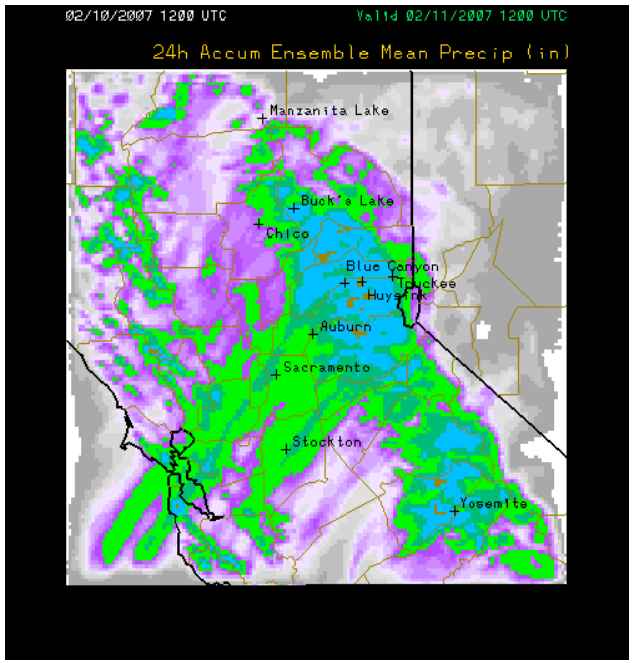


Importance of Downscaling



Pacific moisture

Central CA
Forecast Rain/Snow



Take Pacific scale events…….

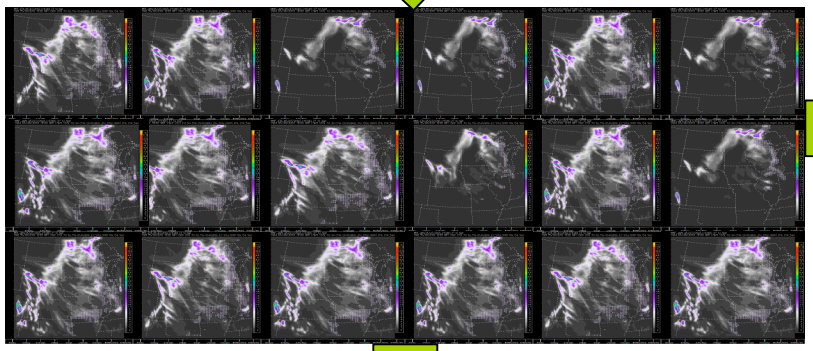
…….. And bring them down to river basin scales, including the American

How an Ensemble-Based System Works

Observations

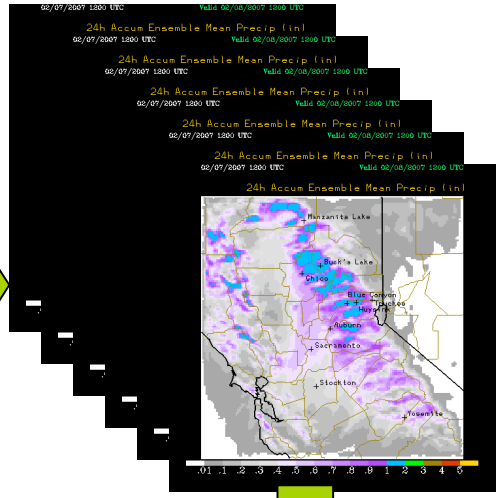
18-Model Ensemble

18 weather opinions



AHPS

18 Basin Rainfall Forecasts

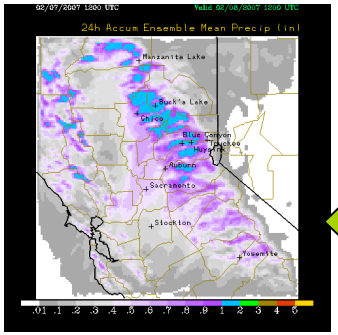


54 Stream/River Flow Scenarios

3 Hydro Runoff Models

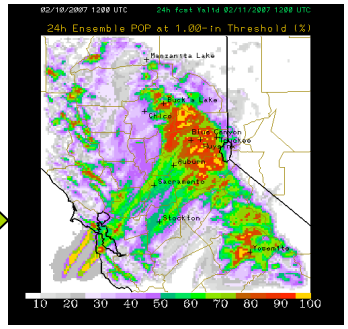
Flow rate Probability

Ensemble Mean



Post processing

Threshold Probabilities

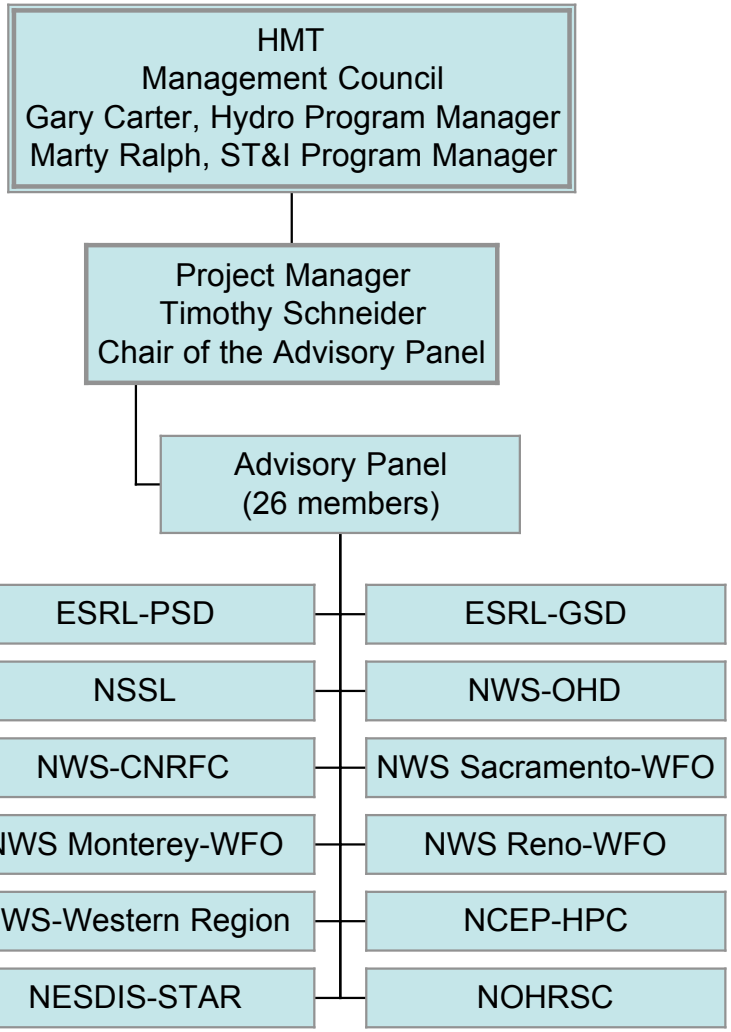


Roadmap to Today's Presentation

3. Proposed Partnership/Collaboration between HMT & GPM GV Template
   - Management
   - Science Objectives
   - Infrastructure
   - Work Projects

Building Partnerships

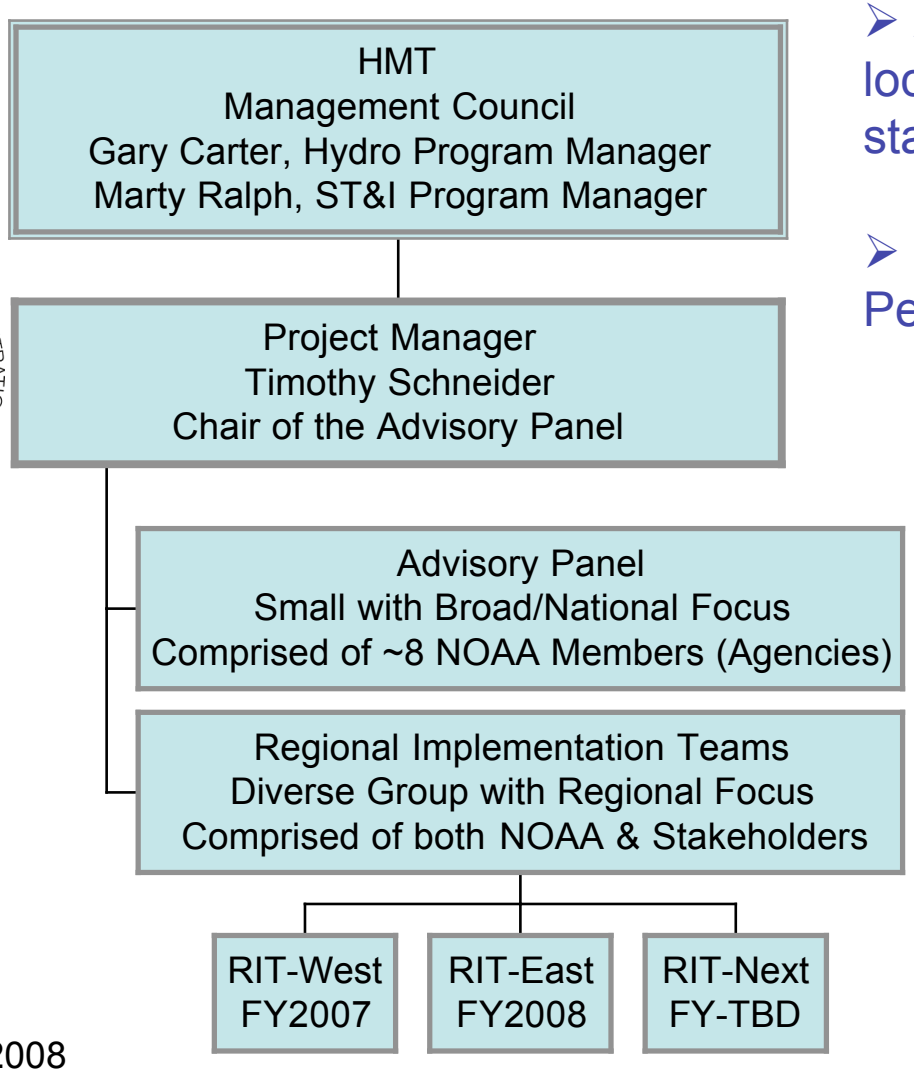
Current Structure



- A critical element: engaging local, state and federal stakeholders…
- Changes to Advisory Panel Pending:
  - Smaller panel with National focus
  - Standup "Regional Implementation Teams" (regional focus; give voice to non-NOAA partners)

Building Partnerships

Proposed Structure



- A critical element: engaging local, state and federal stakeholders…
- Changes to Advisory Panel Pending:
  - Smaller panel with National focus
  - Standup "Regional Implementation Teams" (regional focus; give voice to non-NOAA partners)

End of Today's Presentation

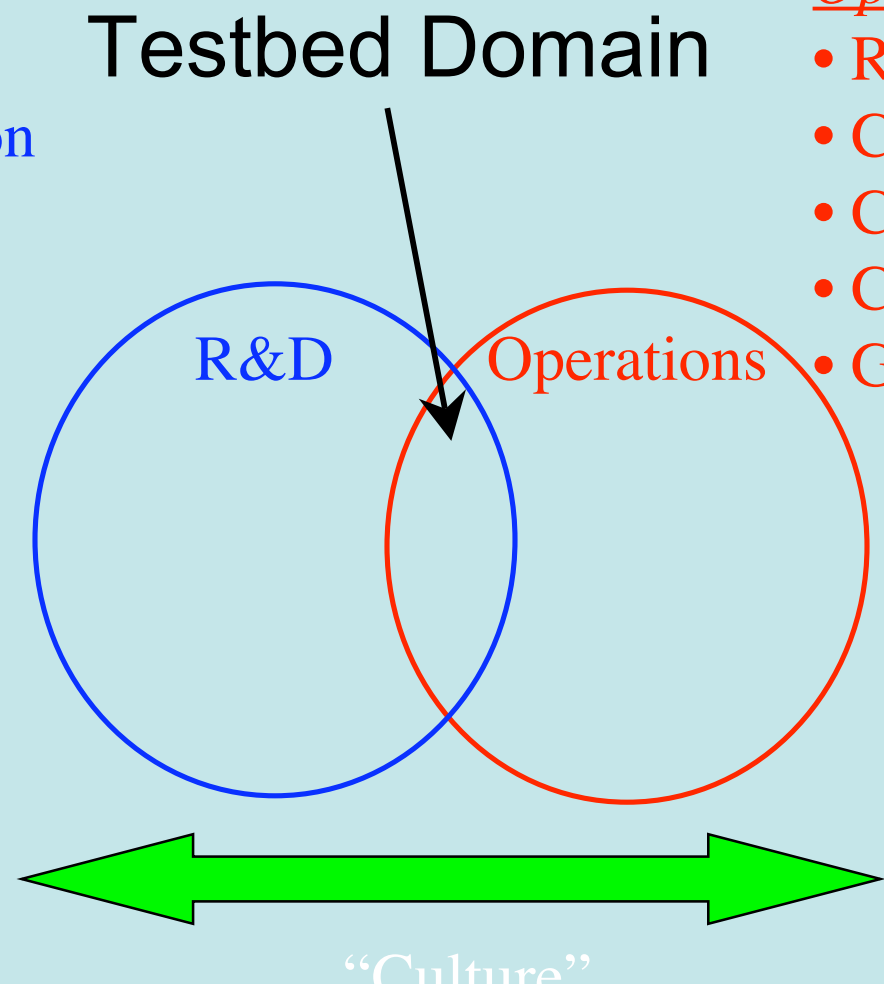
Concluding Remarks:

- NOAA has formed a Steering Group for Global Precipitation (Chaired by Ralph Ferraro).
- HMT-West legacy: working on MOU with California
- Discussions between NOAA NDE & HMT
- NOAA HMT has grown "organically" and we are seeking funding for collaborative efforts through NOAA's long-range planning process.
- NOAA HMT is a process that accelerates the infusion of research and development into operations.
- NOAA HMT looks forward to building a strong and productive partnership and collaboration with NASA PMM/GPM GV.
- NOAA HMT also looks forward to building international partnerships and collaborations with our international colleagues and organizations.
- Partnerships and Collaborations start at the scientist-to-scientist level and build into institutional relationships.


Backup Slides
http://hmt.noaa.gov/

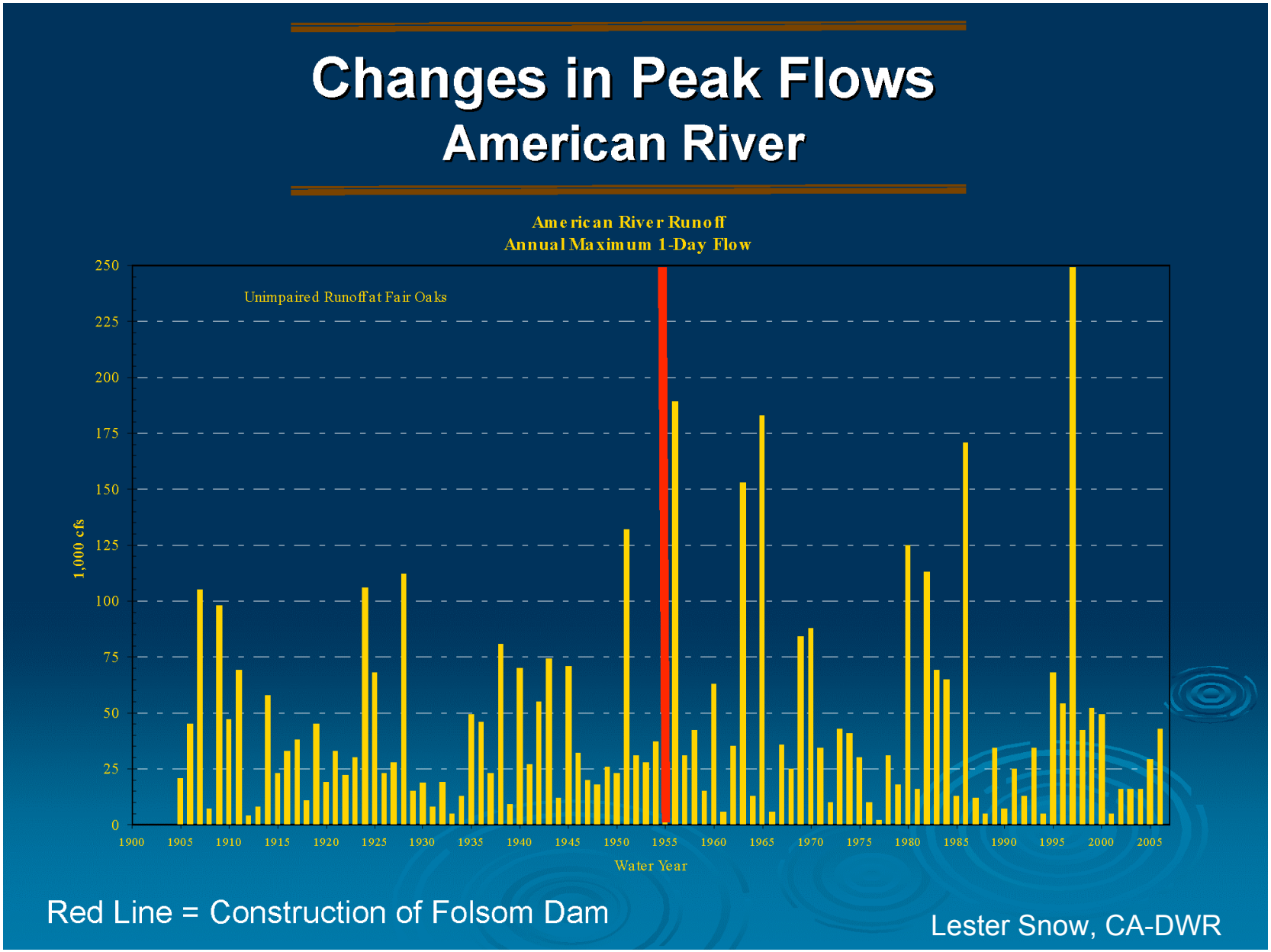
R&D and Operational Paradigms:
How can R&D help Operations?

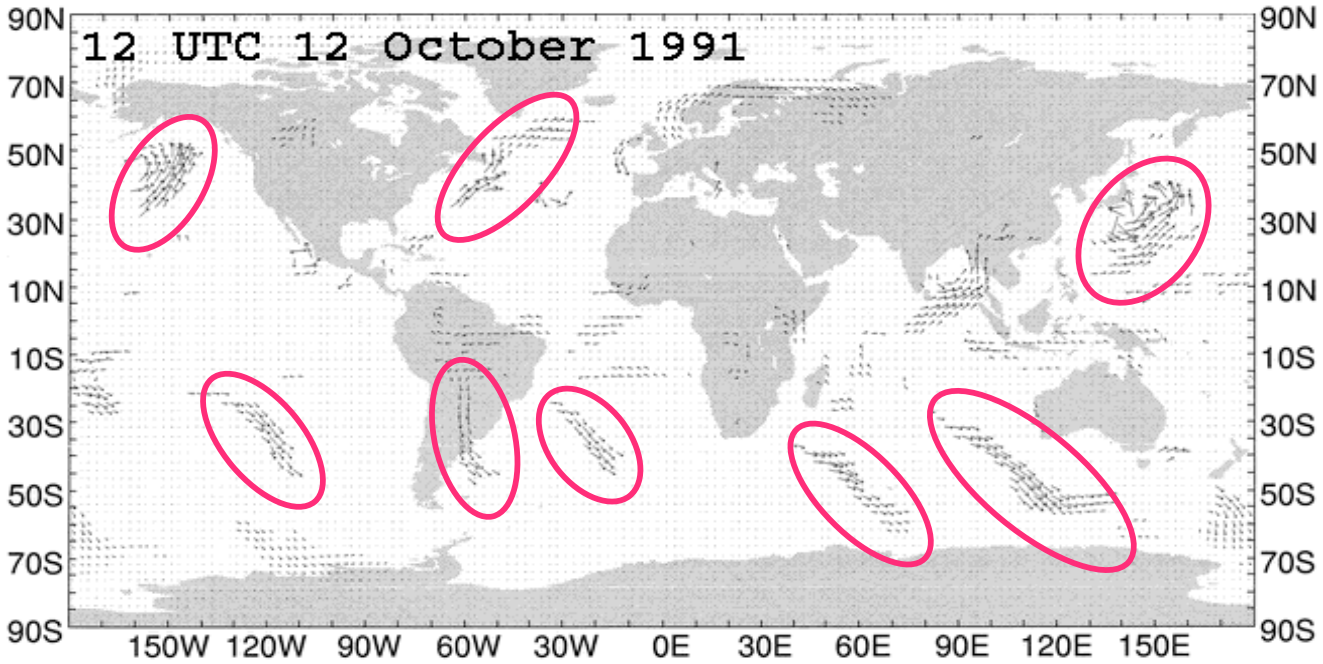
R&D Priorities
- Exploratory
- Higher Resolution
- Multi-Sensor
- New Variables
- Publication



Operational Priorities
- Reliability
- Cost Effectiveness
- COTS (plug n' play)
- Continuity
- GPRA Measures

Why the American River Basin?

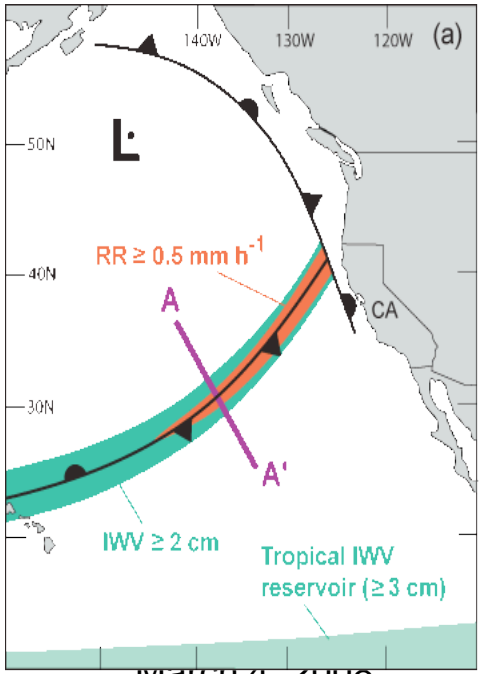


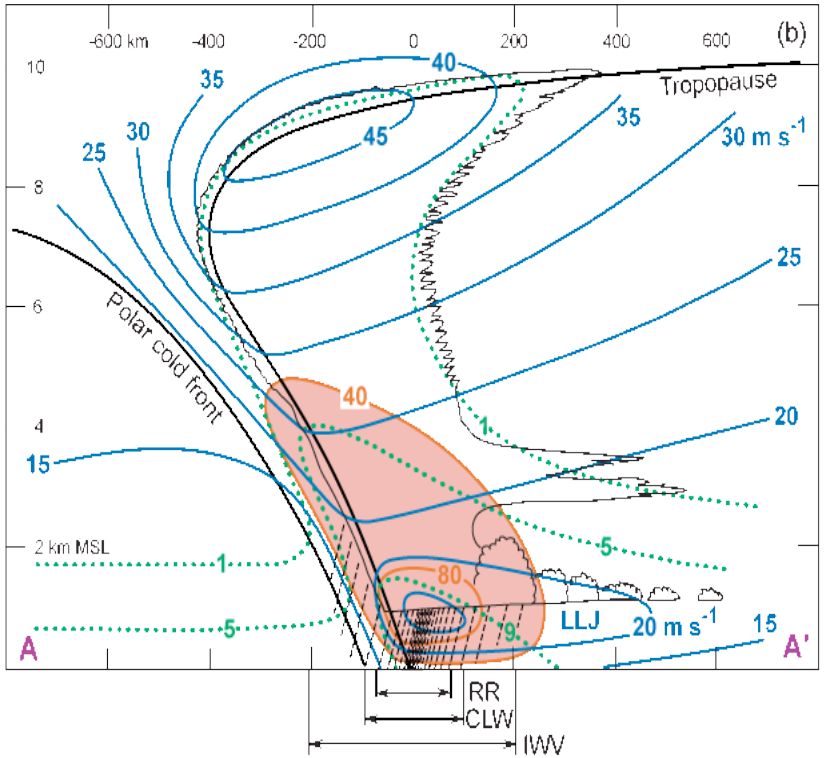


Zhu & Newell 1998

Model diagnostic study using the ECMWF

Atmos. rivers contain 95% of meridional water vapor flux at 35 latitude, but in <10% of the zonal circumference





Ralph et al. 2004

Observations confirm model study

-Lateral structure from satellite data (~400 km width per “river”)
-vertical structure from case study
-Next step: statistically quantify vert. structure

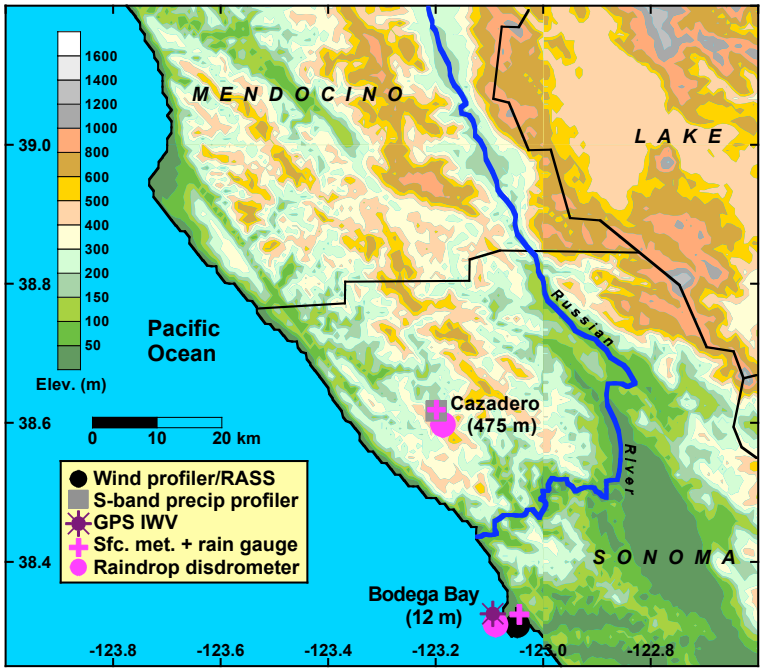
The Anatomy of an Atmospheric River Observatory

Atmospheric River (AR) Observatory: Russian River Prototype

Objectives: Monitor key AR and precipitation characteristics.

Observing systems:

1. Wind profiler/RASS
2. S-band radar
3. Disdrometer
4. Surface met
5. GPS-IWV
6. Rain gauges



Observations & Modeling

- Diagnoses
- Quantitative precipitation estimation (QPE)
- Climate change monitoring
* Assimilation in numerical weather prediction (NWP) models
* Verification
  - Confidence and credibility in QPF is achieved through verified
* Observing System Simulation Experiments (OSSE)
* NWP can improve QPE through assimilation

* Indicates a direct linkage between the observational and modeling components of this vision

Some of HMT-West's Instrumentation

HMT Surface Measurements

10-m met tower

net radiometer (left)
T/RH sensor (right)

prop-vane
anemometer

pyranometer

GPS antenna used to
retrieve integrated
water vapor

total precip.
weighing gauge

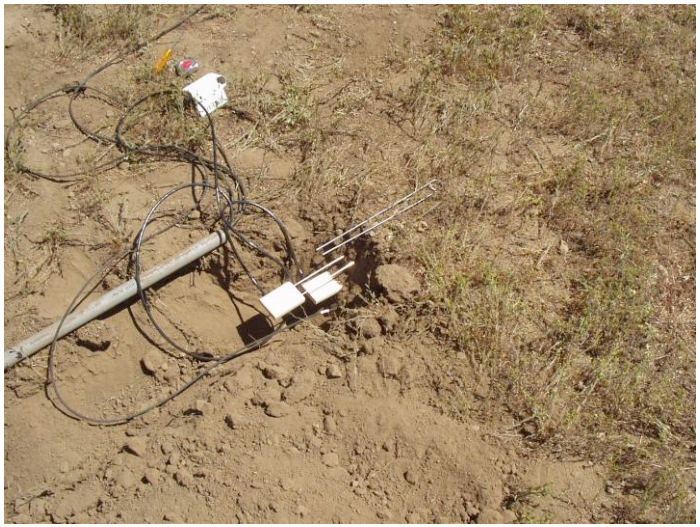
total precip. hot
plate gauge

rain impact disdrometer

HMT Surface Measurements

optical disdrometer

heated tipping bucket gauge



soil temp probes, reflectometer for measuring soil moisture content

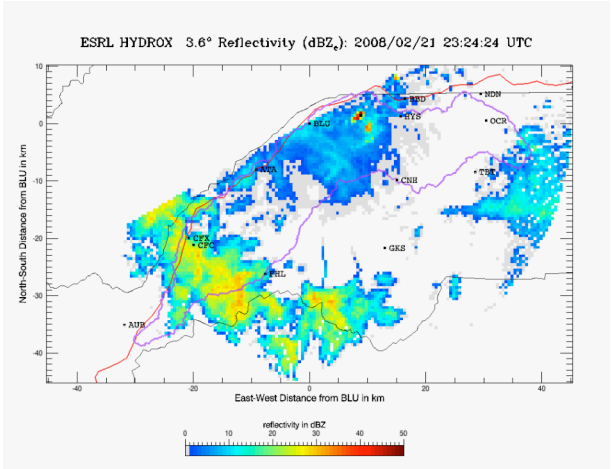
ultrasonic snow-depth sensor

HMT Ground-based Remote Sensing

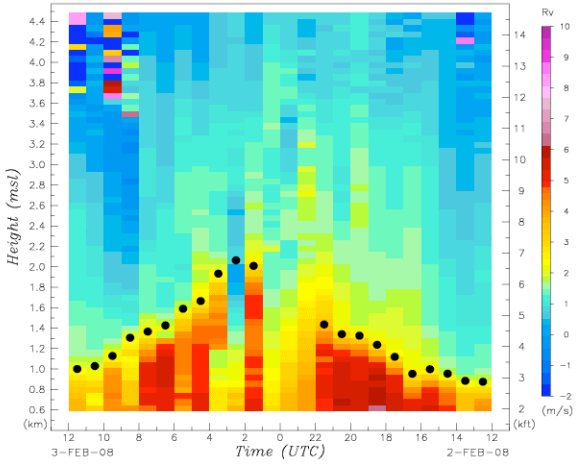
X-band scanning polarimetric radar (HYDROX)

2875-MHz precip. profilers (S-PROF)

915-MHz wind profiler with RASS



March 4, 2008



Time (UTC)	1130	1030	0930	0830	0730	0630	0530	0430	0330	0230	0130	0030
Snow Level (m)	1000	1029	1128	1306	1366	1426	1589	1665	1933	2063	2009	none
Snow Level (ft)	3279	3375	3699	4283	4480	4677	5211	5461	6340	6766	6589	none
Sfc Temp (C)	4.49	4.59	4.99	6.67	7.24	8.07	8.30	8.32	8.42	8.39	8.19	7.84

Time (UTC)	2330	2230	2130	2030	1930	1830	1730	1630	1530	1430	1330	1230
Snow Level (m)	none	none	1436	1341	1326	1237	1119	953	998	954	884	875
Snow Level (ft)	none	none	4710	4398	4349	4057	3670	3125	3273	3129	2899	2869
Sfc Temp (C)	7.27	6.82	6.35	6.05	5.73	5.19	4.41	4.11	3.73	3.41	3.28	2.82